Project Title	Developing algorithms to sculpt light in 3D
Supervisor(s)	Dr Christopher Rowlands
Themes	Neurotechnology and Robotics
Project Type	Lab based
Project Description	Photolithography (literally 'light stone-writing') is widely used in the semiconductor industry for patterning microchips but using light to trigger a chemical or physical change has many uses in biology as well. 3D bioprinting, photodynamic therapy, image recording, and optogenetic control of neurons all employ light to induce a change in a biological system. One important limitation of conventional projection-based optics is that the change is induced by a single photon. This has a subtle problem in 3D applications, because if one wishes to confine the photo-response to a particular plane, the regions above and below the plane are also illuminated. This is a particular problem in optogenetics, a cutting-edge technique in which light is used to excite neurons in the brain. Here, it is desirable to excite one neuron but not the ones above or below, yet this is impossible with conventional optical projection. Fortunately, there is a potential solution - one can use high-speed projectors to make holograms that change very rapidly. None of the projected images are intense enough to trigger a neuron on their own, but the sum of many of them is. One can therefore find a series of patterns that trigger the desired cell but cause the light above and below the desired cell to 'miss' the important regions, thus having no effect. The student for this project will work on developing an algorithm that can, for a given distribution of neurons, find a sequence of holograms that trigger a single cell but don't affect the surrounding cells. They will develop software to control a projector in order to make these patterns, and if everything goes according to plan, it may be possible to test the algorithms in a laboratory setting. The student for this project should have a moderate to strong mathematical background, and some experience in MATLAB or another similar programming environment. If necessary, they should have or be able to develop the lab skills necessary to test their software in real life.